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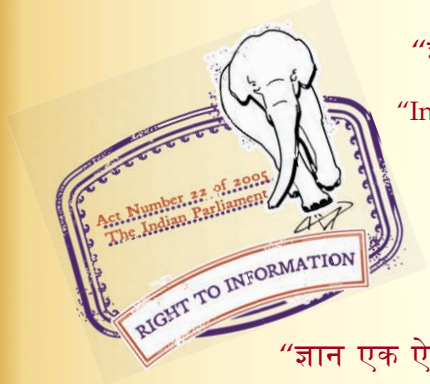
IS 6164 (1971): Code of safety for hydrochloric acid [CHD 8: Occupational Safety, Health and Chemical Hazards]



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"Knowledge is such a treasure which cannot be stolen"

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IS : 6164 - 1971
(Reaffirmed 2003)

Indian Standard

CODE OF SAFETY FOR HYDROCHLORIC ACID

(Third Reprint SEPTEMBER 1997)

UDC 614.878 : 661.419

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 6 *January* 1972

Indian Standard

CODE OF SAFETY FOR HYDROCHLORIC ACID

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(*Continued on page* 22)

Indian Standard
CODE OF SAFETY FOR HYDROCHLORIC ACID

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 21 June 1971, after the draft finalized by the Chemical Hazards Sectional Committee had been approved by the Chemical Division Council.

0.2 Hydrochloric acid is one of the most extensively used chemicals in the industry. A complete knowledge and understanding of the hazards of hydrochloric acid is essential for its safe handling. This standard attempts to guide the users in the recognition of the hazards and recommended handling procedures.

0.3 In the preparation of this standard, considerable assistance has been derived from the MCA Safety Data Sheet No. 39 for Hydrochloric Acid, Aqueous and Hydrochloric Acid, Anhydrous issued by the Manufacturing Chemist's Association, Washington, D.C., USA.

1. SCOPE

1.1 This standard describes properties of hydrochloric acid, the nature of hazards associated with it and essential information on storage, handling, packing, labelling, waste disposal, cleaning and repair of tanks, selection and training of personnel, personal protective equipment and first-aid.

1.1.1 This code does not deal with specifications for design of buildings, chemical engineering plants, storage vessels and equipment for waste disposal and operations control.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 4155-1966* and IS : 4167-1966† shall apply.

*Glossary of terms relating to chemical and radiation hazards and hazardous chemicals.
†Glossary of terms relating to air pollution.

3. PROPERTIES OF HYDROCHLORIC ACID

3.1 Some of the important physical and chemical properties are:

Property	*Aqueous Hydrochloric Acid*	*Anhydrous Hydrogen Chloride*
Physical state	Liquid	Gas at atmospheric pressure
Odour	Sharp, pungent, irritating	Sharp, pungent, irritating
Colour	Clear, colourless to slightly yellow	Clear, colourless. White fumes in moist air
Corrosivity	Highly corrosive to most metals with evolution of hydrogen gas, which is highly explosive when mixed with air	Non-corrosive when dry, rapidly absorbs moisture, forming hydrochloric acid which is highly corrosive to most metals with evolution of hydrogen gas which is highly explosive when mixed with air. Hydrogen chloride gas also reacts rapidly with many organic materials with evolution of heat. Unless controlled, these reactions may become violent
Hygroscopicity	Hygroscopic	Very hygroscopic
Flammability	Non-flammable, but reacts with most metals with evolution of hydrogen which may cause fire or explosion with air	Non-flammable
Boiling point	All aqueous solutions of hydrochloric acid, on boiling, approach a constant boiling mixture which contains 20·24 percent HCl and boils at 110°C	−85°C

Freezing point	−66°C (35·21 percent acid)	−111°C
Vapour pressure	The vapour pressures of all aqueous solutions approach that of the constant boiling point mixture which boils at 110°C at 760 mm	52 atm (absolute) at 30°C
Critical constants	—	81·6 atm (absolute) at 51·5°C

4. HAZARDS ASSOCIATED WITH HYDROCHLORIC ACID

4.1 Health Hazards

4.1.1 *General* — Anhydrous hydrogen chloride is a gas at ambient conditions having corrosive action upon the skin or mucous membranes. In this form it will cause rapid and severe burns. It is particularly dangerous to the eyes. The gas or vapour is so penetrating and pungent that when high concentrations do occur, those exposed immediately leave the contaminated area, unless trapped or unable to do so because of some other injury.

4.1.1.1 The gas is highly soluble in water, forming hydrochloric acid. Concentrated solutions are corrosive and especially dangerous to the eyes. Prompt removal by copious flushing with water often prevents serious damage.

4.1.1.2 The generally accepted threshold limit value for an eight-hour working day is 5 parts of hydrogen chloride per million parts of air by volume (7 mg/m^3).

4.1.1.3 The following effects are observed on exposure to different concentrations of hydrogen chloride in air:

30 ppm by volume	Causes irritation of throat
50 to 100 ppm „ „	Tolerated for not more than an hour
1 000 to 2 000 ppm „ „	Dangerous even for brief exposure

4.1.2 *Acute Toxicity*

4.1.2.1 *Local*

a) *Eyes* — Contact of the eyes with hydrochloric acid, aqueous or hydrogen chloride, anhydrous, rapidly causes severe irritation of the eyes and eyelids. If the acid is not quickly removed by thorough irrigation with water, there may be prolonged or permanent visual impairment or total loss of sight.

b) *Skin* — Concentrated solutions are destructive to clothing, and on contact with the skin, cause severe burns unless promptly washed off. Repeated contact of the skin with dilute solutions may lead to the development of dermatitis. Exposure to the vapour of anhydrous hydrogen chloride may also result in burns or dermatitis.

4.1.2.2 *Systemic*

a) *Inhalation* — Inhalation of excessive concentrations of hydrochloric acid vapours immediately produces severe irritation of the upper respiratory tract, resulting in cough, burning of the throat, and a choking sensation. Such an exposure necessitates prompt voluntary withdrawal from the contaminated atmosphere, when possible. Reactions encountered in man have usually been limited to inflammation and occasionally ulceration of the nose, throat, and larynx. Under rare conditions, if inhaled deeply, edema of the lungs may occur.

b) *Ingestion* — When concentrated hydrochloric acid is swallowed, it causes severe burns of the mucous membranes of the mouth, esophagus, and stomach. The lips and mouth usually turn white, and later, brown. There is pain in the throat and stomach, difficulty in swallowing, intense thirst, nausea, and vomiting, followed by diarrhea and, in severe cases, by collapse and death.

4.1.3 *Chronic Toxicity* — No chronic toxic effects, local and systemic have been established.

4.2 Fire Hazards — Hydrochloric acid, aqueous or anhydrous, as such, involves no fire hazard. However, anhydrous hydrogen chloride readily dissolves in water to form the aqueous acid which attacks most metals with the evolution of explosive hydrogen.

4.3 Corrosion Hazards — Aqueous hydrochloric acid attacks almost all metals with the evolution of hydrogen, which may form explosive mixtures with air. It is one of the most difficult of the acids to handle. The corrosive action of hydrochloric acid on metals increases with increase in temperature, concentration, and other factors.

4.3.1 Anhydrous hydrogen chloride is not very corrosive to metals and may be handled in ordinary steel pipe. Unless leakage occurs, the storage of the material in steel cylinders does not present any particular corrosion hazard. However, the gas absorbs water very readily and the wet gas has corrosive properties.

5. STORAGE

5.0 General — Aqueous hydrochloric acid containers and anhydrous hydrogen chloride cylinders should be stored out of direct rays of the sun

and away from sources of heat. Location of storage should be in the open, or in well-ventilated buildings or sheds. Ample, natural ventilation should be provided.

5.1 Type of Construction — While storage exterior to buildings may be preferable, normal materials, such as wood, concrete, or steel are fairly satisfactory for building construction. Since wood is rather rapidly attacked by hydrochloric acid fumes, which cause embrittlement and warping and may endanger the load bearing capacity of the structure, and since concrete surfaces disintegrate in contact with hydrochloric acid, acid-proof brick is the preferred material of construction. Steel, concrete and wood, when used, should be protected by suitable acid-resistant surface coatings. Provision should be made for drainage and washing down spills with large quantities of water.

5.2 Isolation — Hydrochloric acid should not be stored with or near oxidizing agents, particularly nitric acid and chlorates. Fumes from hydrochloric acid are highly corrosive to metals and thus, indirectly, present health and fire hazards. Therefore, storage should be located outdoors in open sheds or well-ventilated areas whenever possible. All containers should be stored away from highly flammable substances, such as oil, gasoline, paint, waste, and other potential fire areas; also, away from elevators, gangways, and all locations where moving objects may fall upon them. Storage in subsurface rooms is not recommended. Full, empty, or partially emptied containers should be so labeled and separately stored to avoid confusion. Local building codes should be observed.

5.3 Electrical Requirements — Electrical fixtures preferably should be of the vapour-proof type. All wiring should be in tight, rigid metal conduits, all protected with an acid-resisting coating. All electrical equipment should conform to the national electrical specifications wherever existing.

5.4 Venting of Tanks — Each storage tank should be provided with a vent of sufficient size for venting vapours to the atmosphere at an elevation higher than the immediate surroundings. The vent shall be of acid-resisting material, of a type which will maintain the tank at atmospheric pressure, and be capable of being cleaned readily to prevent plugging.

5.4.1 Since hydrochloric acid fumes settle rather rapidly toward the ground in quiet, humid weather, it is recommended, particularly where large quantities of fumes are involved, that the fumes be carried through acid-resistant ducts to a centrally located scrubbing tower. This can be a water ejector constructed of suitable material used as a fume scrubber. Water can be used in the tower to absorb the acid for re-use or for conveying it to a neutralizing pit. Alkaline absorbing solutions in controlled quantities may be used instead of water when conditions warrant their use,

5.4.1.1 An acid-resistant overflow should be provided either in combination with, or separate from, the venting system and should discharge into a limestone-packed, tile drain or sump located well away from building or tank foundations.

5.5 Drums — Drums should be stored with the closures up to prevent leakage, securely blocked on skids, and on a properly drained and dry site. They should be stored out the direct rays of the sun and away from heat, oil, grease, and from all other potential sources of fire. Drums should be vented when received, and at least weekly thereafter, to relieve accumulated internal pressure.

5.6 Carboys — Carboys should be stored, preferably under cover, on floors of acid-resistant brick or concrete treated with sodium silicate. Suitable drainage facilities should be provided. If necessary to store outdoors, carboys should be protected from direct sunlight, be provided with suitable dunnage for the bottom tier and stored in a properly drained site.

5.7 Cylinders — Cylinders should be stored in a cool, dry location, away from sunlight, moving objects, and combustible and reactive materials.

6. HANDLING

6.1 Hydrochloric Acid, Aqueous

6.1.1 Spilled hydrochloric acid should always be attended to. All spillage should be removed immediately by flushing the contaminated area with copious quantities of water. Soda ash or lime should be available for immediately neutralizing spilled acid on concrete, wood, or other reactive or absorbing material. When soda ash is used, ample ventilation should be provided.

6.1.2 Tanks and equipment, pumps, lines and valves should always be drained, flushed, and thoroughly evacuated or purged with water or other fluid, such as an inert gas, before being repaired. The supplier should be consulted as to suitability of purging fluid and potential hazards from such purging. Care should be taken that the purging fluid does not generate flammable hydrogen gas. Workmen should never be allowed to attempt to repair equipment while it is in operation and the lines full of acid. If pipe sections are to be removed and flanges opened, the lower bolts should be loosened first, and although the lines have been flushed, care should be taken to avoid personal contact with any liquid draining or dripping from the equipment.

6.1.3 If it is necessary to remove sections of lines by cutting with a torch, the repairmen should make doubly sure that the lines have been drained, flushed with water or an alkaline solution, and purged with inert

gas before the work is started. Operators engaged in this type of repair work should wear full protective clothing. The hazard of a hydrogen explosion is present when cutting into empty acid lines or empty acid tanks. This hazard may be minimized by forcing a stream of carbon dioxide or another inert gas into the line, or by adding dry ice to the tank before the repair work. Although hydrochloric acid is not explosive, hydrogen is. The use of a torch should be avoided.

6.1.4 *Glass Bottles* — Employees handling glass bottles should be equipped with proper personal protective equipment (*see* **9.5**).

6.1.4.1 Bottles should be carefully handled to avoid breakage. Be sure that the closures are tightened before moving bottles.

6.1.4.2 Do not breathe vapour.

6.1.4.3 All bottles should be carefully inspected on receipt and any broken in transit, set aside for special handling or disposal.

6.1.4.4 When removing bottles from storage tiers, the neck of the bottle should always be tilted away from the workmen or other individuals.

6.1.5 *Carboys* — Employees handling carboys should be equipped with protective clothing consisting of a brimmed felt or treated fibre hat, rubber gloves, chemical safety-type goggles, rubber apron, and rubber safety toe-cap boots or shoes.

6.1.5.1 All carboys should be carefully inspected on receipt and any damaged ones, set aside for special handling or disposal.

6.1.5.2 All closures should be securely fastened before moving either filled or empty carboys.

6.1.5.3 It is a good practice to place a cap or a boot over the neck of the carboy whenever it is moved.

6.1.5.4 Specially designed hand trucks should be used for transporting individually boxed carboys about the plant. Hooks should never be used.

6.1.5.5 Handling carboys by the closure or neck of the bottle is prohibited.

6.1.5.6 Walking a carboy is dangerous because it may break and thus cause serious hand lacerations or other injuries.

6.1.5.7 When removing full or empty boxed carboys from storage tiers, trucks, or cars, and when stacking full or empty carboys, the neck of the bottle should always be tilted away from the workman.

6.1.5.8 Full carboys of hydrochloric acid should never be stacked more than three tiers high. Empty carboys should never be stacked more than four tiers high.

6.1.5.9 When opening carboys, the hands and face should be kept to the side of the carboy neck, never over it. In the case of wired carboys, the recommended method of removing the wire holding the stopper in place is to use a wire cutter (preferably the face type). Never attempt to remove the wire by twisting or prying. To do so, will frequently break the neck of the bottle and injure the workman.

6.1.5.10 Use of air pressure to empty carboys should never be allowed. A tilter especially designed for the purpose, or a siphon fabricated of material resistant to hydrochloric acid should be used.

6.1.6 *Drums* — Any rubber drum showing evidence of damage shall be tested to 1·4 kg/cm^2 hydrostatic pressure before use.

6.1.6.1 The drums should be handled with care to prevent damage. They should not be dropped or allowed to contact any object that may cut rubber. They should not be allowed to contact grease or oils.

6.1.6.2 Protective clothing should be worn when handling drums of hydrochloric acid. The use of brimmed felt or treated fibre hat, rubber gloves, chemical goggles, rubber apron, and rubber safety toe-cap shoes are recommended.

6.1.6.3 All drums should be tested for loose closures and signs of leakage or damage before moving, then set aside for special handling if damage is found. All closures should be tightened.

6.1.6.4 To vent a drum or to remove the closure entirely, a drum should be securely blocked in place with closure up and a plug or socket wrench with a long handle used to open it by applying pressure on the wrench slowly and evenly. Operator should stand to one side of the drum and face away from the closure while loosening. After closure starts, it shall be turned slowly, observing any signs of venting of internal pressure. If drum contains accumulated internal pressure, it should be slowly reduced to atmospheric pressure before removing closure completely. Hammering closures is prohibited.

6.1.6.5 Drums should always be emptied by gravity with the use of a faucet or a safety siphon with a bulk starter, fabricated of materials resistant to hydrochloric acid. *Use of air pressure should not be allowed.* While being discharged, drums should be supported securely to prevent movement. After withdrawals, the drum closure shall be replaced securely.

6.2 Hydrogen Chloride, Anhydrous

6.2.1 Anhydrous acid forms white fumes in contact with air. These may hover around a valve or fitting after it has been completely closed or repaired and give the impression that a leak still exists. Absorption of

moisture converts gaseous hydrogen chloride into moist hydrochloric acid with all its potential hazards.

6.2.2 Anhydrous acid as a low boiling, fuming chemical, is very corrosive. Leaks may result in the discharge of liquid or gas, or both and thus create serious hazards.

6.2.3 Leaks in equipment containing anhydrous acid should be repaired immediately. All pressure in the lines and containers should be reduced to atmospheric pressure and both lines and containers swept clean of the gas by flushing with air or an inert gas before starting repairs. In repairing a leak, the operator should be equipped with full protective clothing and equipment.

6.2.4 Leaks at the outlet valve of a cylinder usually may be eliminated by further tightening the valve stem by bumping the valve wrench with the heel of the hand, turning stem in a clockwise direction. Only wrenches approved by or provided by the supplier should be used. Leaks at the packing gland usually may be eliminated by drawing up the packing nut, turning the nut in a clockwise direction. Leaks through the valve seat that cannot be corrected may be temporarily stopped by applying the valve outlet cap. This is only a temporary measure and an effort shall be made to use or dispose of the cylinder contents safely into an absorption system. The supplier should be consulted where emergency conditions exist.

6.2.5 If a cylinder leak is such that it cannot be stopped by ordinary methods, the cylinder should be removed from the storage area and exhausted to the absorption system, or it should be placed in such a position that it will gradually lose its contents without causing nuisance or damage.

6.2.6 *Cylinders* — No part of any cylinder containing anhydrous hydrogen chloride should be subjected to a temperature above 52°C. A direct flame should never be permitted to come in contact with any part of a cylinder.

6.2.6.1 Care should be taken to protect cylinders from any object that will produce a cut or other abrasion on the surface of the metal.

6.2.6.2 Cylinders should be handled carefully so as to prevent dropping or striking each other.

6.2.6.3 Cylinders shall be moved by a suitable truck equipped with adequate clamps, chains, or other holding devices. Dragging or sliding should be avoided.

6.2.6.4 Use of lifting magnets and slings (rope or chain) should never be permitted. A crane may be used only when a safe cradle or platform is provided for the cylinders.

6.2.6.5 Cylinders should never be used for rollers, supports, or for any purpose other than to carry anhydrous hydrogen chloride.

6.2.6.6 The repair or alteration of cylinders or valves should never be attempted by the purchaser.

6.2.6.7 No attempt should ever be made to mix gases or liquids in a cylinder.

6.2.6.8 Valve protective caps should be kept in place on the cylinders except when the cylinders are connected for discharge.

6.2.6.9 Cylinders should be securely clamped or chained in place while being unloaded.

6.2.6.10 In discharging cylinders, connecting lines to equipment should be strong enough to withstand the maximum operating pressure and be provided with check valves, and with liquid or solid traps to prevent a suck-back of material to be treated into the connecting line and the cylinder. Care should be taken that cylinder threads match threads on all equipment connected to them. Connections that do not fit should never be forced. Pressure gauges and other accessories provided for use with other products shall never be used on cylinders containing hydrogen chloride gas.

6.2.6.11 To discharge the cylinder, the cylinder valve should be opened slowly, and the operator should make sure that the packing nut is tight, then slowly open the cylinder valve by turning valve stem counter-clockwise. No wrenches or tools other than those provided or approved by the supplier should be used. The valve stem or wheel should never be hammered in attempting to open or close the valve.

6.2.6.12 When there is any doubt about the proper handling of a cylinder or its contents, or about piping and flow controls, the supplier should be consulted.

7. UNLOADING OF TANK CARS

7.1 Personal protective clothing should be worn when loading or unloading tank cars. Recommended equipment consists of a brimmed felt or treated fibre hat, chemical safety goggles, rubber gloves, high top rubber safety shoes, and woollen outer clothing. A rubber acid suit should be worn when connecting or disconnecting the car, but the wearing of a complete rubber suit should be limited to short periods to avoid excessive fatigue. Water in ample quantity should be available immediately at the unloading station to flush away any spillage.

7.2 Unloading operations should be conducted by carefully instructed, reliable employees, under adequate and trained supervision, and with ample ventilation and adequate illumination.

7.3 All caution markings on both sides of the tank and dome should be read and observed.

7.4 Caution signs should be so placed on the track or car as to give necessary warning to persons approaching the car and should not be removed until after the car is unloaded and disconnected from discharge connection.

7.5 It is considered good practice that derails be placed at one or both ends of the unloading track approximately one car-length from the car being unloaded, unless the car is protected by a closed and locked switch or gate.

7.6 Dome fittings should be inspected for leaks or other defects before unloading. In the event of a tank car or fitting failure or leak that cannot be stopped by following previous instructions from the supplier, he should be immediately contacted by telephone or wire for further instructions.

7.7 Compressed air, if used, shall be as free as possible from oil, moisture and foreign matter. To ensure this, the air supply should be taken from the TOP of the air receiver (reservoir), which should be drained at regular intervals. The air line leading to the tank car (usually a dead end line which is idle between unloadings) should be thoroughly blown out before it is connected to the tank car.

7.8 Under no circumstances should water or other liquid be introduced into loaded or unloaded car tanks by the purchaser.

7.9 The purchaser should not permit any employee to enter an empty tank car for any purposes whatsoever. Empty tank cars should be returned as promptly as possible.

8. PACKING AND LABELLING

8.1 Packing

8.1.1 *Aqueous Acid*

8.1.1.1 Smaller amounts, such as 3 litres or less, are packed in glass bottles. Up to 60 litres of the acid, may be packed in boxed polyethylene or glass carboys. Rubber drums may be used for not more than 60 litres of acid. For amounts up to 250 litres, rubber lined metal drums may be used. Rubber or glass lined tanks are suitable for storing larger amounts.

8.1.2 *Anhydrous Acid* — It is supplied in cylinders approved by Chief Inspector of Explosives.

8.2 Labelling

8.2.1 *Aqueous Hydrochloric Acid*

8.2.1.1 Each container shall carry an identifying label or stencil. It shall also bear a label depicting the symbol given in Fig. 5 of

IS : 1260-1958*. The lower half of the label shall have the following words printed:

HYDROCHLORIC ACID

WARNING ! CAUSES BURNS !

Avoid contact with skin and eyes.

Avoid breathing vapour.

In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention.

8.2.2 *Anhydrous Hydrogen Chloride* — Each cylinder shall have an identifying stencil or label. It shall also have a label depicting the Fig. 2 of IS : 1260-1958* and shall have the following information printed in the lower half portion:

HYDROGEN CHLORIDE, ANHYDROUS

DANGER ! HAZARDOUS LIQUID AND GAS
UNDER PRESSURE
CAUSES BURNS
EXTREMELY IRRITATING

Do not breathe gas.

Do not expose eyes or skin to the gas.

In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention.

NOTE — Suck-back into cylinder may cause explosion. Under no circumstances should the cylinder delivery tube be inserted in a liquid or gas without a vacuum break or other protective apparatus in the line to prevent suck-back.

9. PREVENTIVE MEASURES

9.0 General — Hydrochloric acid does not present a serious industrial hazard, provided workers are properly instructed and adequately supervised in the proper handling of it. The most important factor in the

*Code of symbols for labelling of dangerous goods. (Since revised and split into various parts)

prevention of injury is to prevent contact of the gas or solutions with the eyes, skin, and the respiratory and gastrointestinal tracts.

9.1 Ventilation — Ventilation should be adequate to maintain the atmospheric concentration at a level that does not exceed the generally accepted threshold limit value of 5 ppm by volume of air.

9.2 Safety Showers and Eye Baths — Readily accessible, well-marked, frequently inspected, rapid-action safety showers shall be available in the areas where hydrochloric acid is handled. The showers should be capable of supplying large quantities of water under moderately high pressure. Blankets should be located near the safety showers. Special eye-washing fountains, a bubbler drinking fountain, or a hose with a liberal, gentle flow of drinking water should be available for eye irrigation. All of the above equipments should be inspected and tested at frequent intervals to ensure its being in good working condition at all times. The locations of such equipment should be marked clearly.

9.3 Physical Examination

9.3.1 *Preplacement Physical Examination* — Prior to assignment to operations involving the handling of aqueous or anhydrous hydrochloric acid, all employees should have a careful preplacement physical examination, and those who have the following conditions should be excluded from such processes:

a) Chronic skin disorders.

b) Chronic diseases of the upper respiratory tract.

c) Only one eye.

d) Seriously impaired vision, uncorrected, in one or both eyes.

9.3.2 *Periodic Physical Examination* — All employees who work constantly with aqueous or anhydrous hydrochloric acid should have a careful physical examination at least once each year.

9.4 Employee Education — Employees working where hydrochloric acid hazards exist should be instructed and trained in the following:

a) Hazards of hydrochloric acid.

b) Location of gas masks and other personal protective equipment, safety showers, bubbler drinking fountains, equipment especially suitable for eye irrigation, water hoses, exits, and first-aid equipment.

c) Proper use of personal protective, emergency, and first-aid equipment.

d) Proper individual conduct in case of emergency.

e) The necessity for reporting to his superior any possible hazard, such as an unusual odour of hydrogen chloride or any evidence of spillage of hydrochloric acid. Contaminated areas should be flushed with copious quantities of water and the acid neutralized with soda ash or lime as quickly as possible. When soda ash is used, ample ventilation should be provided. All employees engaged in this operation should be provided with all the necessary protective devices to prevent personal injury.

f) Key personnel should be drilled in the proper use of emergency equipment and in the actions to be taken in case of acid burns.

g) Workers should be carefully trained in the proper ways of handling the gas and the aqueous acid, and should be supervised until their proficiency in handling is demonstrated.

9.5 Personal Protective Equipment

9.5.1 Personal protective equipment should not be used as a substitute for safe working conditions. The correct use of personal protective equipment requires education of the worker in the proper employment of the materials available to him; it also requires careful and constant supervision of the employee. Personal protective equipment shall always be readily accessible and in good condition. It should be inspected frequently to ensure usability. In addition to protective equipment, facilities capable of supplying copious quantities of flowing water should be readily accessible at all times, as the delay in acquiring these materials in case of personal injury may mean permanent injury or even the death of the employee.

9.5.2 Employees who handle aqueous or anhydrous hydrochloric acid should be provided, when indicated, with the following equipment:

a) Protective clothing.

b) Suitable gas-tight chemical safety goggles.

c) Rescue harness and lifeline for those entering a tank or enclosed storage space.

d) Proper respiratory protective devices. Air-line masks with the proper reducing valve and filter (suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply); or self-contained breathing apparatus with stored oxygen or air, which allows greater mobility but requires more highly trained men. In tank work, small manholes may make this apparatus unsuitable because of its bulk, although the type known as self-generating is especially designed for entrance and egress through small openings. Masks and

breathing apparatus should be approved for their intended purpose by the proper authorities and should be equipped with full face pieces.

e) Industrial gas masks equipped with canisters should be used only when it is certain that the concentration of vapour is less than 2 percent by volume (20 000 parts per million) and the oxygen content is not less than 16 percent, and then only for exposure not exceeding half an hour. This type of mask should not be used in an emergency.

9.5.3 Safety, or 'hard' hats made of treated fibre, should be used to provide protection against accidental liquid leaks, falling tools, or other objects.

9.5.3.1 Brimmed felt hats may be substituted for safety hats where the danger of falling objects is remote.

9.5.4 High rubber shoes with built-in steel toe-caps are recommended for workers handling concentrated aqueous hydrochloric acid. Rubbers may be worn over leather safety shoes.

9.5.5 Wollen outside clothing or other acid resistant fabrics is recommended for workers handling aqueous hydrochloric acid.

9.5.5.1 Rubber or synthetic plastic aprons should be used for protection against accidental contact.

9.5.5.2 Rubber gloves should be worn to protect the hands from these materials, as necessary.

9.5.5.3 The rubber aprons and gloves, of whatever make, should be washed to remove hydrochloric acid from them.

10. FIRST-AID

10.0 General — Speed in removing the patient from the contaminated atmosphere and in removing hydrochloric acid from the skin or eyes is of primary importance. First-aid shall be started immediately in all cases of contact with hydrochloric acid in any form.

10.1 Contact with Skin — Workers who have been exposed to a high concentration of hydrogen chloride, or who have had aqueous hydrochloric acid spilled, splashed, or sprayed upon them should be subjected immediately to a drenching shower of water. Their clothing should be removed as rapidly as possible while they are in the shower, and medical assistance should be summoned at the earliest possible moment (in calling the physician, describe the nature of the injury and the exact location of

the patient). It is essential that all affected body surfaces be washed with copious quantities of running water for a sufficient time to remove all hydrochloric acid. No attempt should be made to neutralize the acid with alkaline solutions.

10.1.1 It should be borne in mind that in cases of severe or extensive burns, shock symptoms, such as rapid pulse, sweating, and collapse, may occur at any time. If such symptoms should appear, keep the patient lying on his back and keep him warm (but not hot) until a physician arrives. No oils or oily ointments should be applied to the burned areas without specific direction from the attending physician.

10.2 Contact with Eyes — If even minute quantities of hydrochloric acid, in either strong or dilute solution, enter the eyes, or if the eyes have been exposed to strong concentrations of hydrochloric acid, they should be immediately irrigated with copious quantities of running water for at least 15 minutes. The eyelids should be held apart during the irrigation to ensure contact of water with all accessible tissues of the eyes and lids. A physician, preferably an eye specialist, should be called in attendance at the first possible moment. If a physician is not immediately available, the eye irrigation should be continued for a second period of 15 minutes. After the first period of irrigation is completed, it is permissible as a first-aid measure to instill into the eye two or three drops of a 0·5 percent solution of pontocaine or other equally effective aqueous topical anaesthetic. No oils or oily ointments should be instilled unless advised by the physician.

10.3 Inhalation

10.3.1 Exposed individuals usually leave the contaminated atmosphere immediately, if possible. Therefore, the extent of injury is not likely to be greater than inflammation of the upper respiratory tract. Oxygen usually furnishes relief from coughing. If one familiar with administering oxygen is present, its application should be continued for at least 15 to 30 minutes.

10.3.2 In order to prevent the development of a severe lung congestion (pulmonary edema), 100 percent oxygen should be administered as soon as possible after any exposure suspected of being severe. Oxygen administration is most effective if expiration is made against a measured resistance. This may be accomplished readily by use of metered pressure masks which are available for this type of treatment, or it may be accomplished by use of a rubber tube connected to the inlet valve of a snugly fitting face mask and inserted to a depth of not more than 6 cm, below the surface of water in a suitable container. It is advisable to start with a very low resistance (1 cm) and increase gradually to the point of tolerance. The pressure resisting exhalation should be adjusted to the patient's tolerance by

varying the depth of the end of the tube below the water's surface or adjust the pressure in the metered mask. Oxygen inhalation shall be continued as long as necessary to maintain the normal colour of the skin and mucous membranes. In cases of severe exposure, the patient should breathe 100 percent oxygen under positive exhalation pressure for half an hour periods every hour for at least three hours. If there are no signs of lung congestion at the end of this period, breathing is easy, and the colour is good, oxygen inhalation may be discontinued. Throughout this time, the patient should be kept comfortably warm, but not hot.

10.3.3 Stimulants will rarely be necessary where adequate oxygenation is maintained. Any drugs for shock should be given only by the attending physician.

10.4 Ingestion

10.4.1 If a person has swallowed aqueous hydrochloric acid and is conscious, he should immediately be made to drink copious amounts of lime water or milk of magnesia. Use plain water if these are not readily available. Do not use sodium bicarbonate. The patient may be expected to vomit spontaneously, but no attempt should be made to induce vomiting. Do not attempt to use a stomach tube. Summon a physician at once, describing in detail the nature of the accident and the exact location of the patient.

10.4.2 *Nothing should ever be given by mouth to an unconscious patient.* While awaiting the arrival of the physician, watch the unconscious patient closely for evidence of obstruction to breathing. His tongue should be kept well forward in his mouth, and false teeth should be removed. Placing the patient in a face-down position will aid considerably in preventing aspiration of vomitus.

11. TANK CLEANING AND REPAIRS

11.1 General Principles

11.1.1 Before a tank is entered, tests should be made by a qualified person to determine if further washing is necessary, and during the course of the work, further tests should be made to ensure that no oxygen deficiency exists and that no harmful gas or vapour, particularly hydrogen, is present. Written permission of the supervisor shall be obtained by the repair or cleaning crew.

11.1.2 Pipelines into or out of the tank or other apparatus should be disconnected, preferably by removing a complete small section, and a blank flange should be secured on the open end of the line to protect against human error and unsuspected leaks. Valves, cocks, and blank flanges in the pipeline should not be relied upon alone.

11.1.3 The operator should make sure that the tank can be left by way of the original entrance.

11.1.4 The electrical switches should be locked in the off position, and the drive belts should be removed. The operators should be completely safeguarded against an accidental start of the agitating equipment or other moving parts located inside the tank or adjacent to the entrance.

11.1.5 Before directing men to enter a tank, the foreman should make an inspection of the interior. He should be equipped with either a hose mask, an airline mask, or a self-contained breathing apparatus, together with a rescue harness and life lines. Another person should be on guard during the inspection.

11.1.6 Special ventilation and a continuous fresh air supply are recommended during the entire time men are cleaning, inspecting, or repairing the tank. Asphyxiating gases are not readily detected, and it is best to guard against these by forced ventilation from a blower located outside the tank.

11.1.7 Proper personal protective equipment should be worn by anyone entering a tank for inspection, cleaning, or repairs.

11.1.8 One man on the outside of the tank should keep the men in the tank under constant observation, and at least two men should be available to aid in rescue if any of those in the tank are overcome.

11.1.9 A hose mask, an air-line mask, or a self-contained breathing apparatus, together with rescue harness and life line, should be located outside the tank entrance. This equipment should be used for rescue, if necessary, regardless of the type of respiratory protection or the air supply which is provided for employees inside the tank.

11.1.10 In addition to protecting the workmen actually engaged in the cleaning and repairing of tank, attention should be paid to the protection of workers in nearby areas.

11.1.11 The portable electric lights should be of the 6-volt type if possible, and power tools should be of the three-wire, grounded, explosion-proof type approved for use in hazardous locations. They should be maintained in excellent condition.

11.2 Entering Tanks

11.2.1 The tank or equipment should first be emptied completely of all liquid.

11.2.2 The remaining gas in the tank should then be vented to the absorption system, the tank opened, and all pipes leading to and from the tank drained, disconnected, and blanked off.

11.2.3 The tank should be filled with water or other suitable wash liquid and drained once or twice, inlet and exit lines disconnected and blanked off, and all switches opened. Due to possible attack of tanks and containers by wash liquids, the supervisor should be consulted on proper wash liquid to be used in each case. If necessary, soda ash or lime may be added in sufficient quantity to neutralize any residual acid. (Use of soda ash will result in evolution of carbon dioxide, which will displace the air if insufficient ventilation is provided). The tank may then be filled with water and drained, or hosed and drained. After this, it should be thoroughly purged with fresh air. The tank should then be in a condition to permit entry.

11.2.4 A wooden shovel and bucket may be used to clean out any residual sludge or water.

11.2.5 An adequate supply of fresh air should be provided all the time the tank is being cleaned or repaired.

12. WASTE DISPOSAL

12.1 Aqueous Hydrochloric Acid

12.1.1 Waste disposal of aqueous hydrochloric acid and materials contaminated with it depends to a great extent upon local conditions. For appreciable quantities of acid, neutralization with an alkaline material is usually required before disposal into a surface water. Since certain agencies of local, state, and central governments have been established to protect the waters of the country from pollution, all rules and regulations applying to a given location should be ascertained and observed.

12.1.2 When waste acid is discharged into a city system, neutralization with controlled quantities of alkali should be employed to prevent corrosion of the city sewerage system. Neutralization by passage through a bed of limestone or oyster-shell may be employed when conditions permit and warrant.

12.2 Anhydrous Hydrogen Chloride — Elimination of waste anhydrous hydrochloric acid may be accomplished by absorption in a packed tower through which water or an alkaline solution is circulated. In any absorption system, provision shall be made to prevent suck-back due to the high solubility of hydrochloric acid gas in water. The disposal of the recovered aqueous hydrochloric acid, or of the alkali chloride, will depend upon the economics of the case and upon local conditions, regulations, and ordinances.

(*Continued from page* 2)

Panel for Drafting Safety Codes for Hazardous Chemicals, CDC 18 : 4 : 1

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